

PATENT
Application Serial No. 09/448,124
Attorney Docket No. JNP-0013

Amendments to the Specification:

Please replace the fifth complete paragraph on page 1, with the following rewritten paragraph:

A key problem in designing routers is to make them scale to a large aggregate bandwidth. There are two ways to do this, increasing the speed of individual line cards and increasing the number of line cards. Technology places hard limits on the speed of individual line cards, so the only way scale throughout is to increase the number of line cards.

Please replace the second complete paragraph on page 2, with the following rewritten paragraph:

A centralized controller works well for a relatively small router, however it rapidly becomes unimplementable with increases in the number of line cards. The storage and processing requirements of the central controller grow at least as the square of the number of line cards, making this approach of limited utility in scaling routers to a large size.

Please replace the first complete paragraph on page 12 with the following rewritten paragraph:

Referring to Figure 2, a switching device 30 includes a data path 40 50. Data path 40 50 includes a switch fabric 54, source line cards 58 and destination line cards 66. The data path provides paths for transferring packets from the source line cards 58 to destination cards 66. Unlike a conventional router, the present invention does not require a separate control path. More specifically, the data path is used to control traffic through switching device 30. The use

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of the data path in the control of data transfers through switching 30 is described in greater detail below.

Please replace the second complete paragraph on page 12 with the following rewritten paragraph:

Referring to Figure 3, data path 40 50 includes an input system 52 having one or more (N) source line cards 58, a switching fabric 54 coupled to input system 52 to receive and transfer data, and an output system 56 having one or more (N) destination line cards 66 and coupled to switching fabric 54 to receive the data. Switching fabric 54 can be a three-stage Clos network. In the implementation shown, switching fabric 54 includes a plurality of crossbars (F1 first stage crossbars 60) in a first stage that are coupled to source line cards 58. A plurality of crossbars (F3 third stage crossbars 64) comprise the third stage of switching fabric 54 and are coupled to destination line cards 66. The second stage of switching fabric 54 includes a plurality of crossbars (F2 second stage crossbars 62) connected between the F1 first stage crossbars 60 and the F3 third stage crossbars 64. A single line card can include both source and destination line card functionality, even though Figure 3 shows each as distinct elements of the switching device.

Please replace the paragraph beginning on the bottom of page 12 and ending on page 13 with the following rewritten paragraph:

Referring to Figures 3 and 4, a process for sending data from a source line card 58 to a destination line card 66 is shown. A source line card 58 receives a data packet and divides the packet into one or more cells (step 40). The process for dividing packets ~~into~~ into fixed length

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cells is described in co-pending patent application to Pradeep Sindhu et al, entitled "Memory Organization In A Switching Device", filed 07/24/97, Serial No. 08/901,061, now U.S. Patent No. 6,493,347, the contents of which are expressly incorporated herein by reference. For each cell, source line card 58 sends a request signal to destination line card 66 via switching fabric 54 (step 42). The request signal includes source and destination line card numbers for the packet. Responsive to the receipt of the request signal, destination line card 66 returns a grant signal via switching fabric 54 that is received by the request generating source line card 58 (step 44). The grant signal also includes the source and destination line card numbers for the packet. A grant signal indicates that the respective destination line card 66 is available to receive a cell from the designated source. Upon receiving the grant signal, source line card 58 transmit a data cell to destination line card 66 (step 46).

Please replace the paragraph beginning on the bottom of page 22 through the top of page 23 with the following rewritten paragraph:

Referring to Figure 14, switching fabric 54 may include a plurality of independent Clos networks, i.e., planes 55. Each plane 55 contains L number of F1 first stage crossbar 60, L number of F2 second stage crossbar 62 and L number of F3 third stage crossbar 64, as described above with reference to Figure 3. Each plane 55 has bandwidth B_f/p , where B_f is the bandwidth of switching fabric 54 and p is the number of planes in the switching fabric. The fabric bandwidth B_f may be increased by adding additional planes 55 to switching fabric 54. In one implementation, switching fabric 54 has four planes 55. Figure 14 shows an implementation where source line card 58 and destination line card 66 are included in a single line card which is

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therefor connected to one of input ports 61 of F1 first stage crossbar 60 and one of output ports 63 of F3 third stage crossbar 64 for each plane 55.

Please replace the first complete paragraph on page 29 with the following rewritten paragraph:

The selection operation includes the selection of a next column to process in the counter array. More specifically, arbiter 176 uses column pointer 186 (not shown) to select a next column in counter array 174 which contains a counter with a non-zero count (step 192). Arbiter 176 examines, in a round-robin order, starting from the column selected on the last arbitration cycle until it finds a column having a counter with a nonzero value. Arbiter 176 uses first summary bits 178 to quickly determine whether a column has a counter with a nonzero count. For example, given a counter array with 16 columns, first summary bits 180 having the value of 0000,1000,0000,1000 indicates that fourth and twelfth columns of counters have counters with non-zero values since the fourth and twelfth bits from the right have a binary value 1.

Please replace the second complete paragraph on page 29 with the following rewritten paragraph:

Once a column is selected, arbiter 176 uses a row pointer 184 (not shown) associated with that column to select a counter with a nonzero count within that column to service (step 194). As with selecting a column, arbiter 176 examines each row in a round-robin order starting from the row selected on the last arbitration cycle until it finds a row having a counter with a nonzero value. Arbiter uses second summary bits 180 to quickly determine which group of

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counters have a counter with a nonzero value. For example, given a counter array with 256 rows divided into groups of 16 (counters), second summary bits 180 having the value of 0100,0000,0000,0100 indicates that the third and fifteenth groups of counters have nonzero values within that block of counters. The individual counter within a group can be selected by evaluating each of the individual counters.